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Puccinia species new to Azad Jammu & Kashmir, Pakistan

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Abstract — *Puccinia persistens* subsp. *agropyrina* on *Elymus semicostatus* and *P. variabilis* on *Taraxacum officinale* are newly recorded for Pakistan while *P. punctiformis* on *Cirsium arvense* and *P. absinthii* on *Artemisia brevifolia* are additions to the rust flora of Azad Jammu & Kashmir.

Key words — Muchal, Neelum valley, Sharda

Introduction

Azad Jammu & Kashmir (AJ & K) lies in northeast Pakistan. Due to the wide topographic variations, plant species are highly diverse in this area. Its flora ranges from the thorn bush type of the arid plains to the temperate and alpine flora of higher altitudes. Prominent among the trees are *Taxus wallichiana, Cornus macrophylla, Diospyros lotus*, *Viburnum cylindricum*, *Acer oblongum* and *Rhus succedanea.* Common shrubs include *Juniperus squamata, Sageretia theezans*, *Dodonaea viscosa, Solanum verbascifolium, Lonicera quinquelocularis*, and *Lyonia ovalifolia*. Perennial herbs include *Geranium nepalense, Boenninghausenia albiflora*, *Oxalis acetosella,* and *Androsace umbellate*. About 10.6% of the total flora of Pakistan is represented in AJ & K and adjacent northern areas of Pakistan (Ali & Qaiser 1986).

Although this floristically rich area has a number of host plants, it is still poorly explored with respect to the occurrence of rust fungi. Until now, 25 rust species have been described/reported from AJ & K (Afshan et al. 2010, 2011). These figures indicate that the number of rust species collected from these areas is small in relation to the vegetation.

In order to explore the diversity of *Uredinales* of this area, rusted plants were collected from different localities in AJ & K. Among these, *Puccinia*

persistens subsp. *agropyrina* and *P. variabilis* are new records for Pakistan while *P. punctiformis* on *Cirsium arvense* and *P. absinthii* on *Artemisia brevifolia* are additions to the rust fungi of AJ & K.

Materials & methods

Freehand sections of infected tissue and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with a digipro-Labomed. Drawings of spores and paraphyses were made using a Camera Lucida (Ernst Leitz Wetzlar, Germany). Spore dimensions were taken by an ocular micrometer. At least 25 spores were measured for each spore stage. In addition to comparisons using light microscopy, images were obtained of the rust spores using a scanning electron microscope (SEM). The rusted specimens have been deposited in the herbarium of the Botany Department, University of the Punjab, Lahore (LAH).

Taxonomy

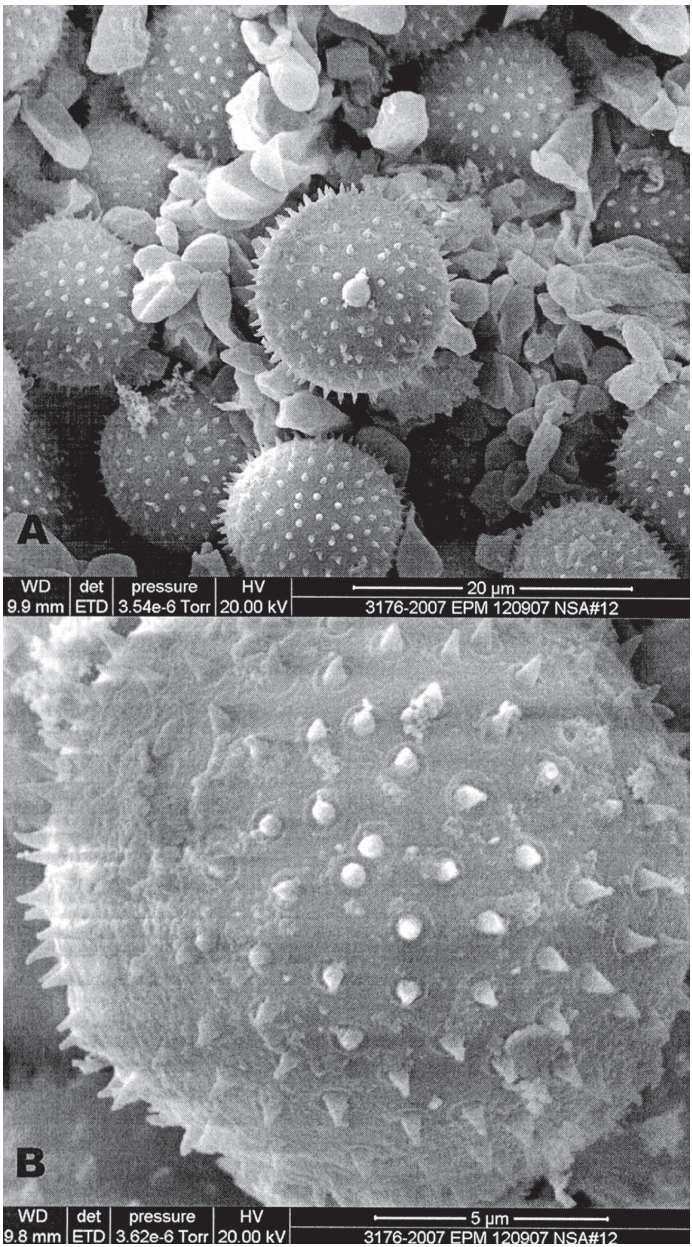
Puccinia persistens* subsp. *agropyrina (Erikss.) Z. Urb. & J. Marková, in Marková, Boln Soc. argent. Bot. 18(1–2): 180 (1977) (Figs. A–D)

Material examined: On *Elymus semicostatus* (Nees ex Steud.) Melderis (≡ *Agropyron semicostatum* Nees ex Steud., *Poaceae*) with II and III stages, Pakistan, Azad Jammu & Kashmir, Neelum valley, Sharda, at 1981 m a.s.l., 3 November 2006. NSA # 31106. (LAH Herbarium No. NSA 1060).

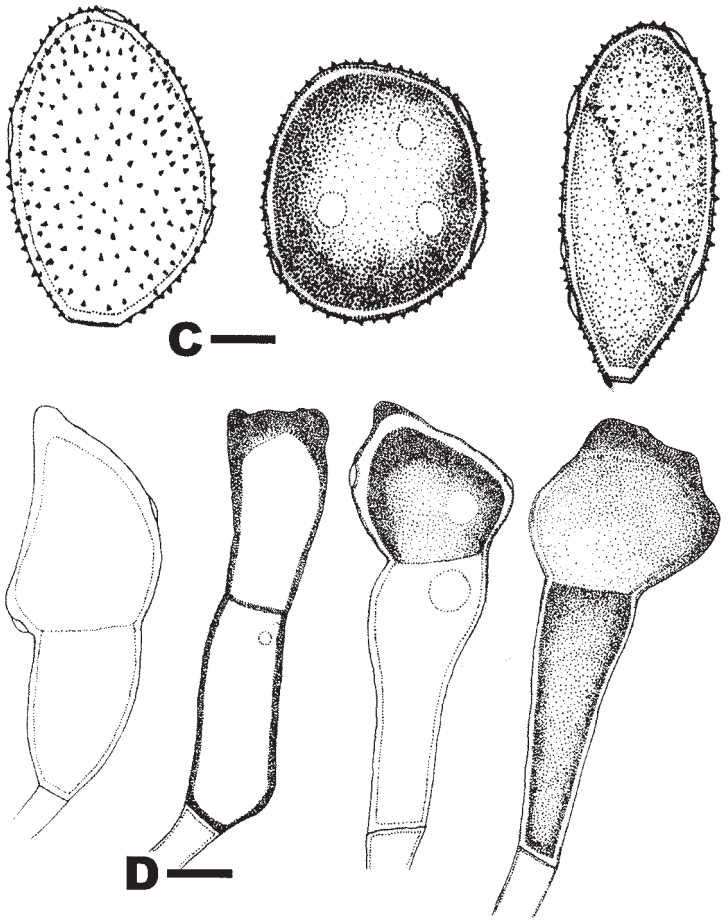
Spermogonia and aecia unknown. Uredinia on abaxial surface, brown, 0.04–0.06 × 0.07–0.1 mm. Urediniospores globose to subglobose or ovoid to obovoid; 13–19 × 18–26 µm; wall up to 2 µm thick, echinulate, hyaline–light yellow; germ pores up to 7, scattered, obscure; pedicel hyaline, not persistent, short. Telia on adaxial surface, black, covered by the epidermis, with brownish stromatic paraphyses tending to divide the sorus into locules, striiform, 0.05–0.08 × 0.1–0.3 mm. Teliospores 1–2-celled, 1-celled spores less common; 11–20 × 30–58 µm; mostly nearly cylindrical or elongate to obovoid, constricted at the septum; wall 0.5–1.5 µm thick at sides, 2–6.5 µm thick apically, apex conical to smooth, sometimes with few digitations; brown to chestnut-brown, paler basally. Pedicel brown, short, less than 15 µm long.

Comments: *Puccinia persistens* was once considered closely related to *P. recondita* and is still included by some in this broad species complex. Concepts of species subspecific taxa differ considerably with respect to *Puccinia recondita*, with some authors stressing a narrow species concept (and thus recognizing many separate species, subspecies, or varieties) while others used a broad species concept (Abbasi et al. 2005).

While researching the species complex *Puccinia recondita* s. lat. in detail, Abbasi et al. (2005) morphologically and molecularly compared different specimens in this complex with other *Puccinia* species on cereals and grasses.



Figs. A–B. *Puccinia persistens* subsp. *agropyrina*: Scanning electron micrographs. (A). Uredinium containing urediniospores. (B). Urediniospore showing echinulate wall ornamentation.

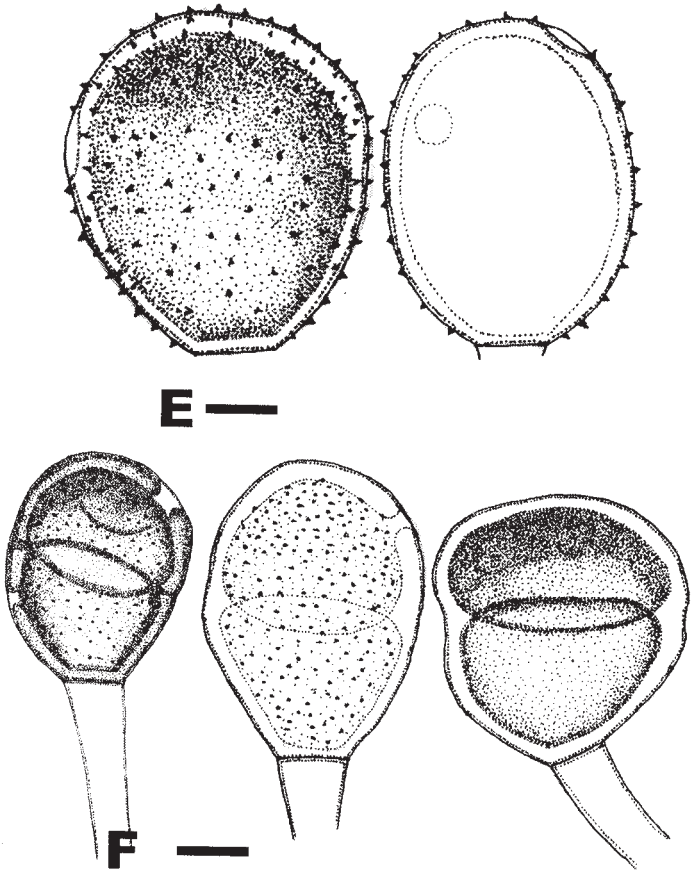


Figs. C–D. *Puccinia persistens* subsp. *agropyrina*: Lucida drawings. (C). Urediniospores (D). Teliospores. Scale bars: C = 8 μm; D = 14 μm.

The ITS sequence data supported a narrow species concept, so that Based upon molecular and morphological comparisons, Abbasi et al. (2005) proposed that the name *P. persistens* subsp. *triticina* be restricted to wheat leaf rust and *P. persistens* subsp. *agropyrina* be used to refer to leaf rust on *Elymus* spp.

Rust fungi previously reported on *Elymus*/*Agropyron* from Pakistan include *P. recondita* and *P. agropyri* on *Agropyron orientale*, *P. graminis* on *A. semicostatum,* and *P. graminis* subsp. *graminicola* on *Agropyron* sp. (Ahmad et al. 1997).

Puccinia persistens subsp. *agropyrina* is a new record for Pakistan.



Figs. E–F. *Puccinia variabilis:* Lucida drawings.
(E). Urediniospores. (F). Teliospores. Scale bars = 10 μm.

Puccinia variabilis Grev., Scott. crypt. fl. (Edinburgh) 2: pl. 75 (1824) (Figs. E–F)

Material examined: On *Taraxacum officinale* (L.) Weber (*Asteraceae*), with II + III stages, Pakistan, Azad Jammu & Kashmir, Neelum valley, Sharda, at 1981 m a.s.l., 3 November 2006. NSA # 902. (LAH Herbarium No. NSA 1099).

Spermogonia and aecia not found. Uredinia amphigenous, but mostly hypophyllous, brown to yellowish brown, scattered, rounded, 0.09–0.1 × 0.3–0.4 mm. Urediniospores subglobose to obovoid, pale brown to yellowish brown, 17–26 × 23–28.32 μm (22 × 26 μm on the average); germ pores 2–3, equatorial; echinulate, wall 1–2 μm thick; pedicel minute, hyaline, not persistent. Telia

amphigenous, but chiefly hypophyllous, dark brown to black, scattered or clustered, naked, irregular patches, 0.09–0.1 × 0.3–0.5 mm. Teliospores ellipsoid to broadly ellipsoid or obovoid, rounded at both ends, not or slightly constricted at the septum, 19–26 × (23–)25–36 µm (mean 24 × 32 µm); wall 1.5–3 µm thick, chestnut brown, finely verrucose, mostly smooth; germ pores 2, sub apical in distal cells and between the pedicel and septum in proximal cells, with hyaline papilla; pedicel hyaline, about as long as the spore, 7–9 × 17–35 µm.

Comments: *Puccinia variabilis* is a new record for Pakistan. From Pakistan, *P. hieracii* (= *P. taraxaci*) and *P. sylvatica* have previously been reported on *Taraxacum officinale* from Swat, Kalam, Kaghan, and Batakundi by Ahmad (1956a,b), Malik et al. (1968) and Malik & Virk (1968); and *P. silvaticella* on *Taraxacum* sp. from Kaghan valley by Ono (1992).

Puccinia punctiformis (F. Strauss) Röhl., Deutschl. Fl., Edn 2 (Frankfurt) 3: 132 (1813) (Fig. G)

Material examined: On *Cirsium arvense* (L.) Scop. (≡ *Cnicus arvensis* (L.) Roth) (*Asteraceae*), with II + III stages, Pakistan, Azad Jammu & Kashmir, Neelum valley, Muchal, at 3000 m a.s.l., 3 November 2006. NSA # 789. (LAH Herbarium No. NSA 1082).

Spermogonia and aecia unknown. Uredinia hypophyllous, intermixed with telia, dark brown, scattered, pulverulent, 0.09 × 0.2–0.3 mm. Urediniospores globose to subglobose, 23–28 × 26–30 µm, pale brown to chestnut brown, uniformly echinulate; germ pores 3–4, mostly 3, equatorial; wall 2–2.5 µm thick; pedicel hyaline, minute. Telia hypophyllous, dark brown to black, scattered

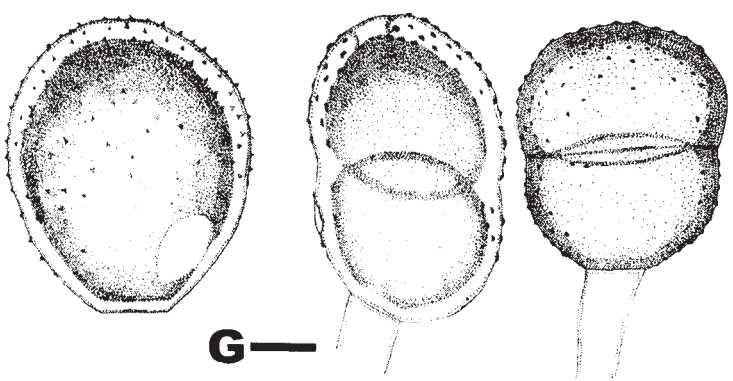
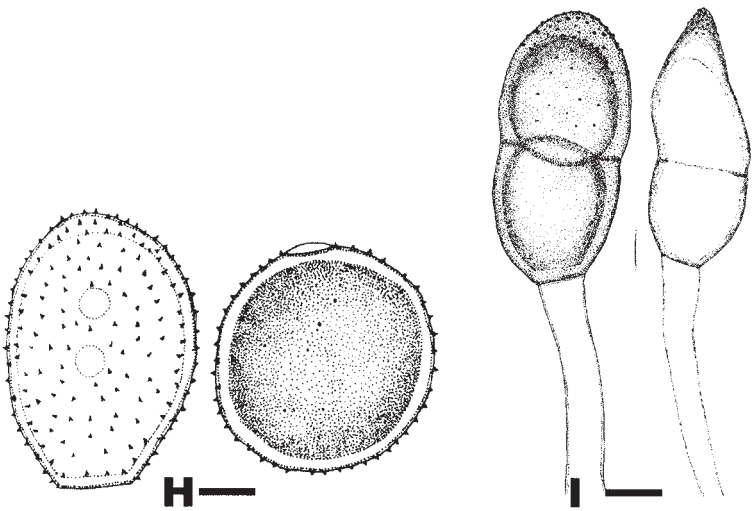


Fig. G. *Puccinia punctiformis:* Lucida drawings of urediniospore and teliospores. Scale bar = 10 µm.

or aggregated in the form of colonies, 0.09–0.1 × 0.2–0.3 mm. Teliospores ellipsoid to broadly ellipsoid or obovoid, finely verrucose, rounded at both ends, not or slightly constricted at the septum, pale yellow to chestnut brown, 20–28 × 26–38 µm, apex 2–5 µm thick, wall 1.6–3 µm thick; germ pore in upper cell apical or sub-apical, in lower cell equatorial; pedicel hyaline, mostly oblique, 5–9 × 4–16 µm.

Comments: Previously, *P. punctiformis* has been reported on *Cnicus arvensis* from Shahdara, Changa Manga, Dass, and Lahore by Ahmad (1956b), but it is an addition to the *Uredinales* for AJ & K.



Figs. H–I. *Puccinia absinthii*: Lucida drawings.
(H). Urediniospores. (I). Teliospores. Scale bars = 8 µm.

Puccinia absinthii DC., Fl. Franç. 6: 56 (1815) (Figs. H–I)

Material examined: On *Artemisia brevifolia* Wall. (*Asteraceae*), with II & III stages, Pakistan, Azad Jammu & Kashmir, Neelum valley, Sharda, at 1981 m a.s.l., 3 November 2006. NSA # 901. (LAH Herbarium No. NSA 1097).

Spermogonia and aecia unknown. Uredinia amphigenous, light brown, scattered, rounded, 0.09–0.2 × 0.2–1.0 mm. Urediniospores ovoid or obovoid to ellipsoid, light yellow to pale brown, 16–24 × 23–32 µm (21 × 28 µm on the average); germ pores 2, equatorial, without a papilla; echinulate, wall 1.5–2 µm thick at sides, 3–4 µm thick apically; pedicel hyaline, short, not persistent. Telia amphigenous, on leaves, small pustules, roundish, dark brown to black, scattered, 0.09–0.1 × 0.3–1.0 mm. Teliospores ellipsoid to broadly ellipsoid

or obovoid, not or slightly constricted at the septum, attenuated towards base, 22–30(–33) × (38–)40–57 µm (mean 27 × 46 µm), chestnut brown, wall 3–3.5 µm thick at sides, 4–7.5 µm thick apically, apex conical or rounded, verruculose at the apex, smooth at lower side; germ pores 2, apical or sub apical in distal cells and close to septum in proximal cells, with hyaline papilla; pedicel hyaline, persistent, 4–12 × 84–142 µm.

Comments: Previously, *P. absinthii* has been reported on *A. persica* and *A. parviflora* from Quetta, Chitral, and NWFP by Ahmad (1956a, b), Malik et al. (1968) and Malik & Virk (1968), on *A. dubia* from Swat by Ono & Kakishima (1992), and on *A. dracunculus* from Kaghan valley by Ono (1992). It is a new record for AJ & K.

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